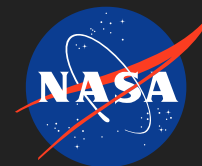


# Numerical Simulation of Rocket Exhaust Interaction with Lunar Soil, Phase I

Completed Technology Project (2007 - 2008)



## Project Introduction

Rocket plume impingement may cause significant damage and contaminate co-landed spacecraft and surrounding habitat structures during Lunar landing operations. Under this proposed SBIR program, CFDRRC and the University of Florida will develop an innovative high-fidelity simulation system for predicting surface erosion and debris transport caused by rocket plume impingement on lunar surface. This simulation system will combine 1) a unified continuum-rarefied flow solver capable of simulating plume impingement flow in lunar vacuum, 2) granular flow solid-fluid interaction technology for developing lunar soil grain erosion and debris particle release mechanism models, and 3) particle tracking tools to simulate debris kinetics, dispersion and contamination after liberation. In Phase I, the plume stagnation layer flow conditions at the soil surface will be modeled and computed. The solid-fluid interaction physics in the soil layer in response to this surface flow environment will be simulated and a generalized soil erosion model will be derived. The erosion model will then serve to prescribe debris mass and initial conditions for the debris-tracking module embedded in the flow solver. In Phase II, the individual modules will be combined into a single simulation system. The simulation system will be essential for predicting the severity and range of dust and debris transport and for designing lunar settlement layout, dust and debris impact mitigation measures. He will spend at least 35 % of his time on this project and his commitment to other projects is less than 50 %.

## Anticipated Benefits

Many potential non-NASA commercial applications exist in civil and military industries. Dust, sand and snow stir-up during helicopter landing and take-off in a desert or arctic environment result in severe visibility impairment (brown-out), windshield abrasion and danger of debris ingestion. Civil engineering and environmental engineering applications include wind-borne landscape erosion and dust transport to populated areas. The debris simulation tool will be of first order importance to the Space Exploration program for lunar robotic and human mission architecture definition. The tool will be equally applicable to follow-on Mars robotic and human missions. The developed technology will also be applicable for analysis of solid propulsion systems with embedded solid particle



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## Table of Contents

Project Introduction	1
Anticipated Benefits	1
Organizational Responsibility	1
Primary U.S. Work Locations and Key Partners	2
Project Management	2
Technology Areas	2

## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Center / Facility:

Kennedy Space Center (KSC)

### Responsible Program:

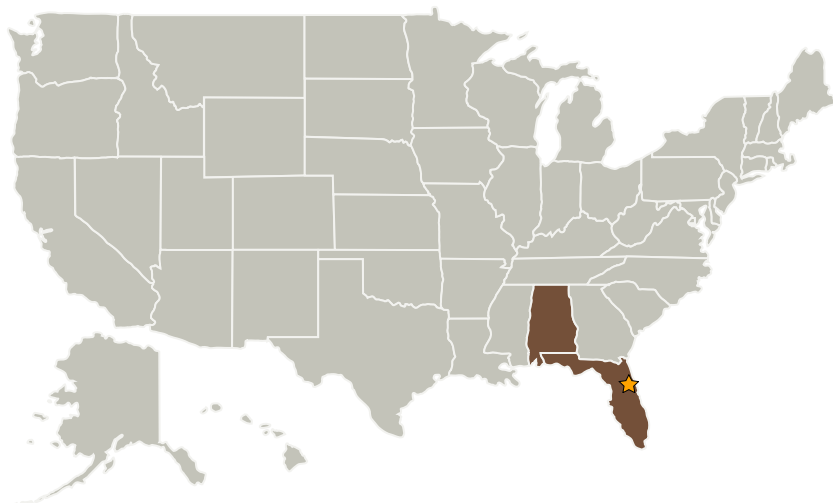
Small Business Innovation Research/Small Business Tech Transfer

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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Kennedy Space Center(KSC)	Lead Organization	NASA Center	Kennedy Space Center, Florida
CFD Research Corporation	Supporting Organization	Industry	Huntsville, Alabama

## Primary U.S. Work Locations

Alabama	Florida
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## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

Carlos Torrez

**Project Manager:**

Philip T Metzger

**Principal Investigator:**

Peter A Liever

## Technology Areas

**Primary:**

- TX09 Entry, Descent, and Landing
  - └ TX09.4 Vehicle Systems
  - └ TX09.4.5 Modeling and Simulation for EDL